Starting a Drone Program

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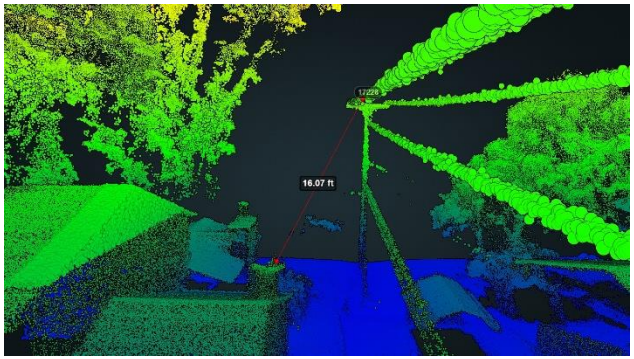
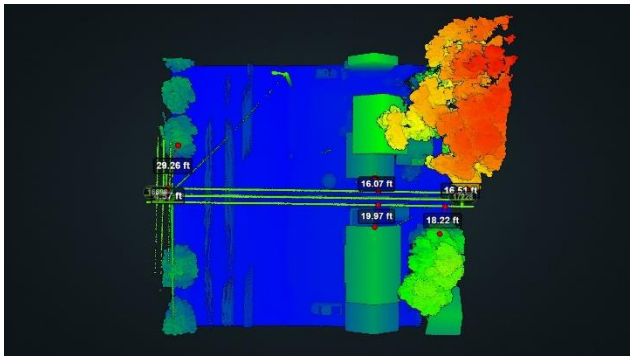
Starting a Drone Program

- Research and Justification
- UAS Service Provider
- Starting an in house program





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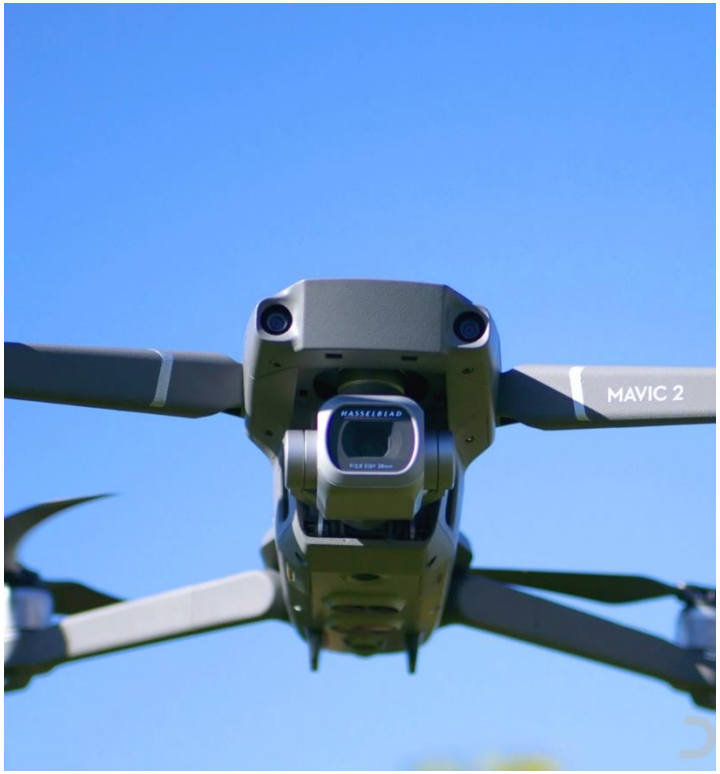
Research & Justification

- Conferences, Webinar, and White Papers
  - Reduce risk, improve efficiency, better data
  - Quick Return on Investment
- Met with RPU stakeholders and subject matter experts
  - Identified several processes that could be supplemented with drones



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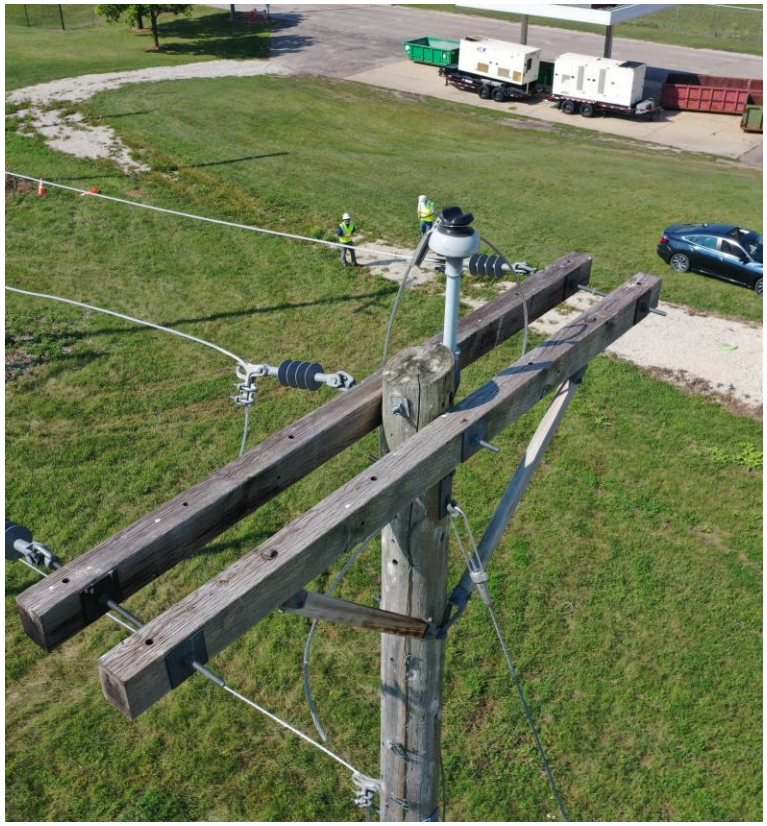
Transmission and Distribution Inspections



- Identified an opportunity to supplement our infrastructure inspection program with drone technology
- Regular, repeatable process with well document criteria
- Drones are well suited for the task

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Benefits of Drone for Inspections

- Safety
  - Backyard line inspections won't require people climbing over barriers to inspect RPU assets
  - Ability to inspect assets from a safer distance away from the structure
- Reliability
  - Ability to conduct inspections without having to de-energize assets causing customer outages
  - More frequent inspections to identify and fix defects before failure
- Reputation
  - continually re-evaluating work processes and leveraging new technology

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Finding a UAS Service Provider

- Professional services for our initial inspection
- Deliverables:
  - Raw imagery
  - Per structure reports identifying any defects
  - Cloud storage and web application

First Inspection

- Distribution and Transmission
  - 48 distribution poles
  - 315 transmission poles
- Inspection took place over a week
  - 2 crew members, pilot and visual observer
- Results
  - 7,000 images
  - 80 documented defects of varying severity

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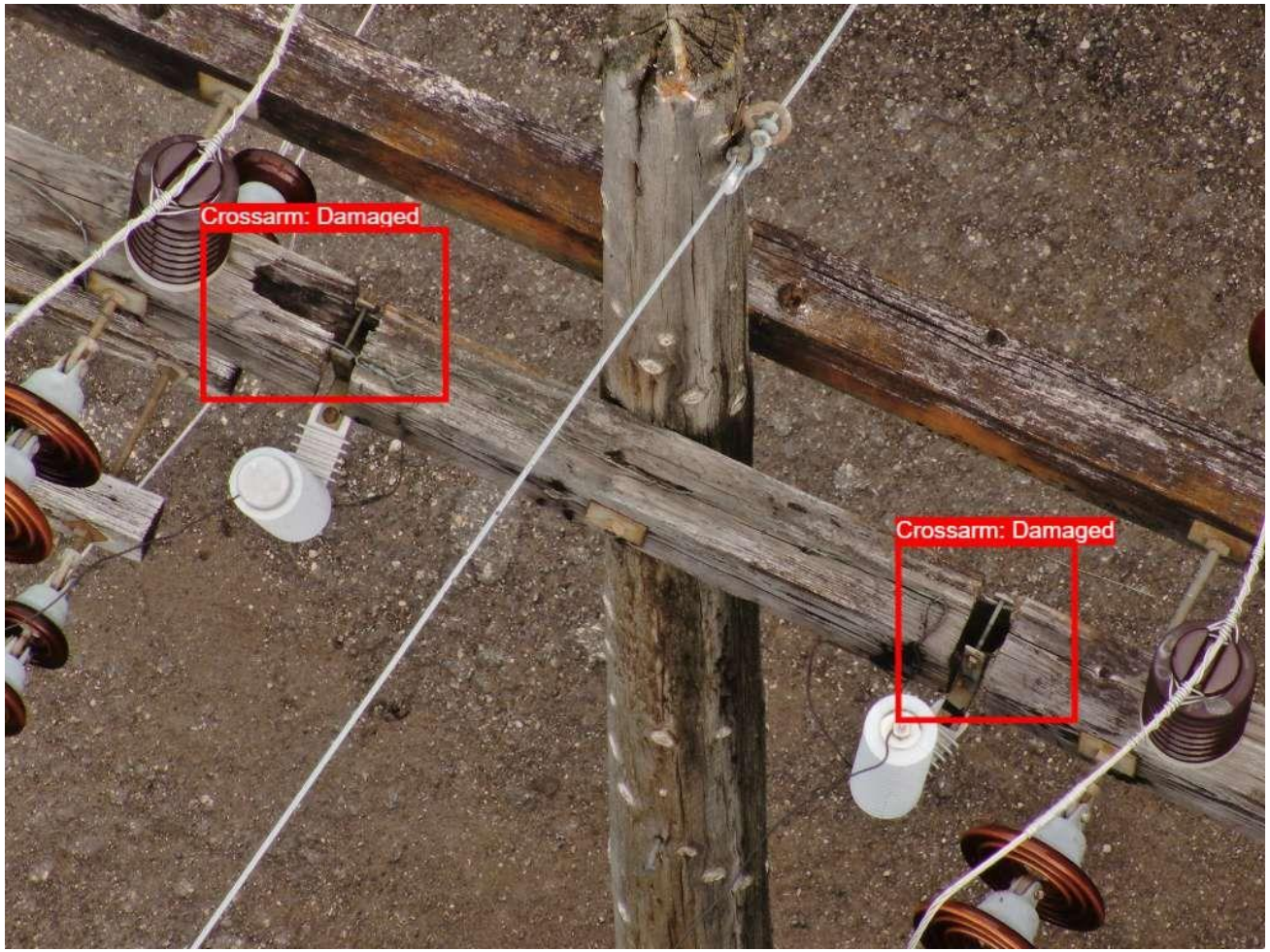
Inspection Results



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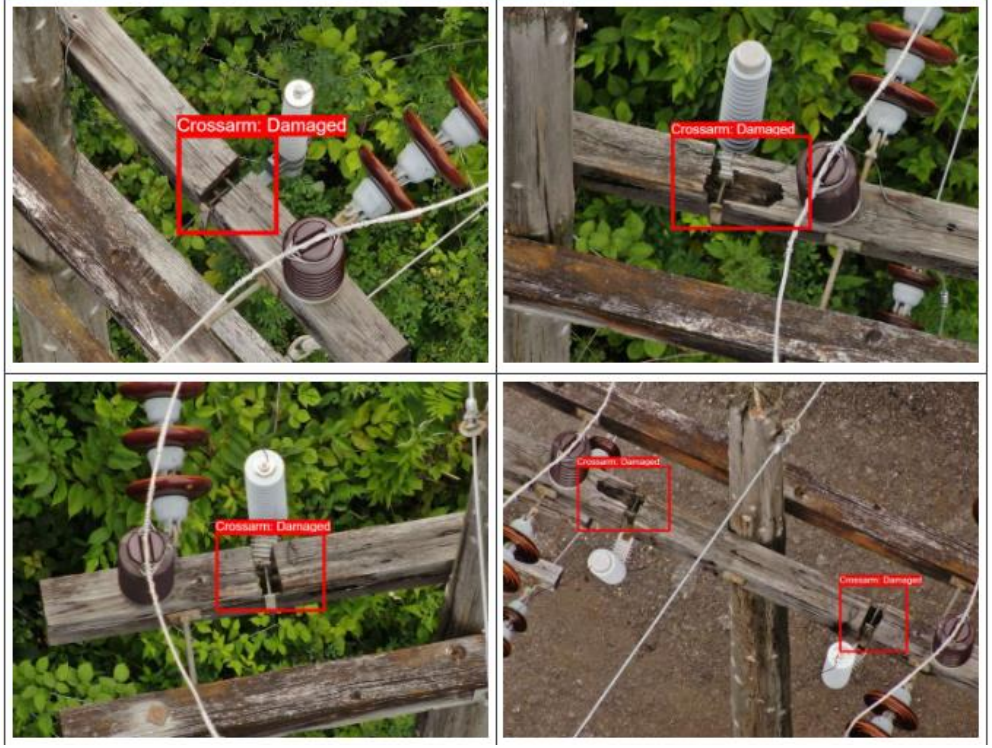
Inspection Results

CONDITION BASED MONITORING (CBM)

34.5kV Hydro Line

TOWER NAME	24191	TOWER TYPE	Wood
INSPECTION DATE	22/07/2021	COORDINATE	44.2130182777778,-92.480973
TIME	04:36	AMBIENT TEMPERATURE	21.00 °C
HUMIDITY	55%	WEATHER	Partially cloudy
VISUAL INSPECTION	Distribution		
	-		
CROSSARM	DAMAGED		

VISUAL IMAGE



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Inspection Results

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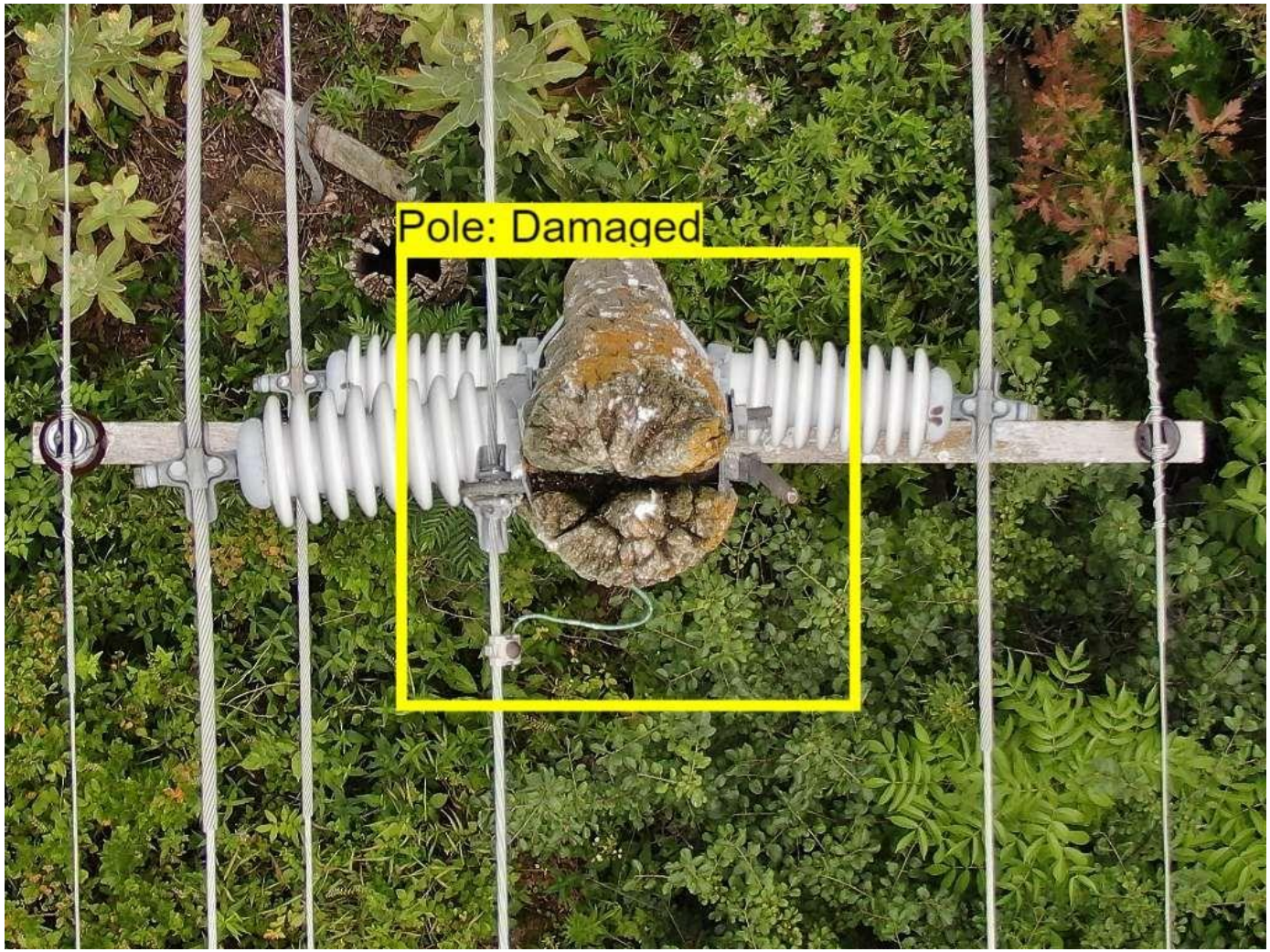

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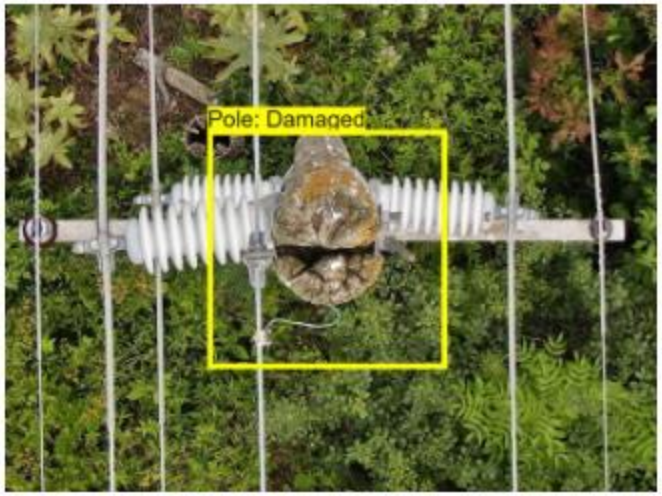
Inspection Results

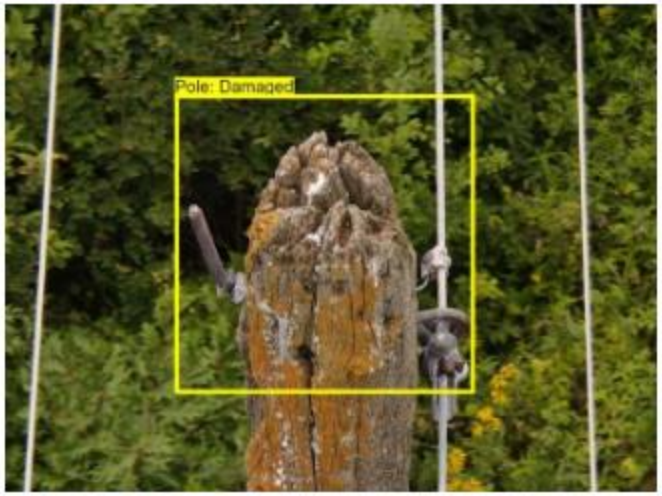
CONDITION BASED MONITORING (CBM)

34.5kV Hydro Line

TOWER NAME	24192	TOWER TYPE	Wood
INSPECTION DATE	22/07/2021	COORDINATE	44.2130229722222,-92.4815684722222
TIME	04:34	AMBIENT TEMPERATURE	21.00 °C
HUMIDITY	55%	WEATHER	Partially cloudy
VISUAL INSPECTION	Distribution		
	-		
POLE	DAMAGED		

VISUAL IMAGE





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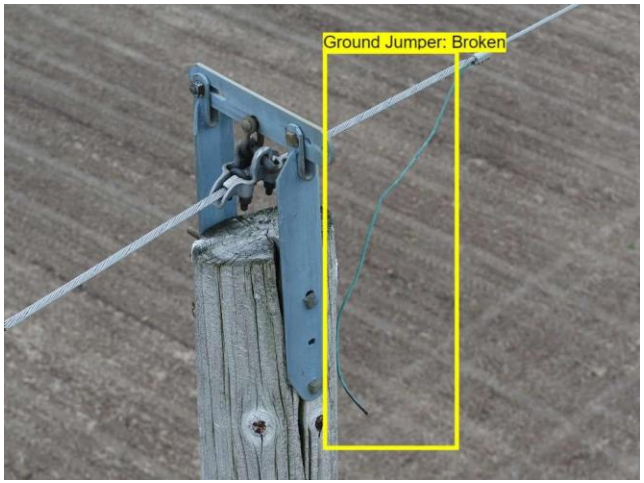

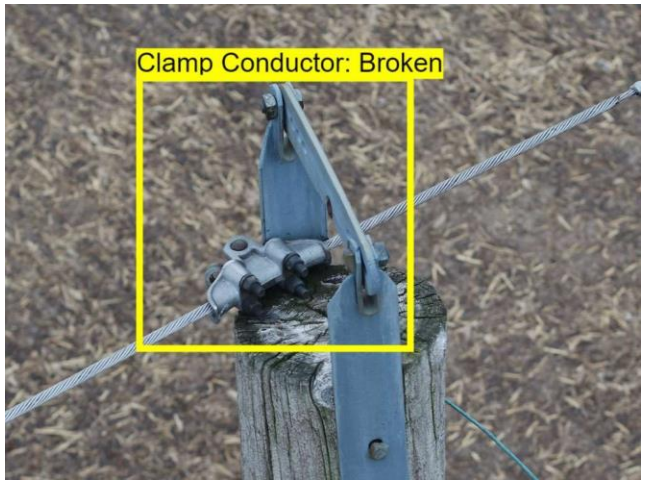

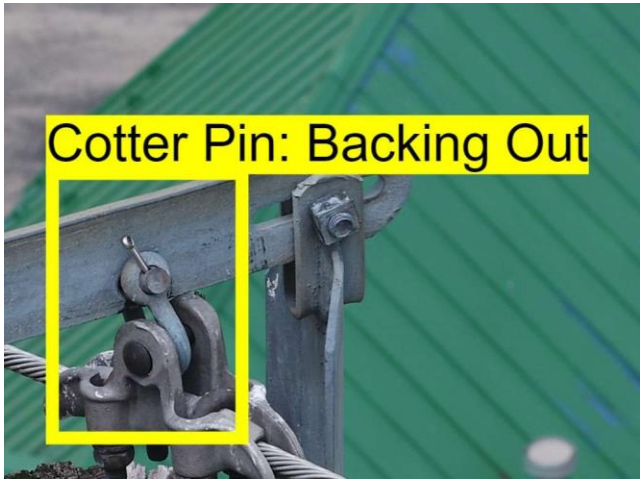

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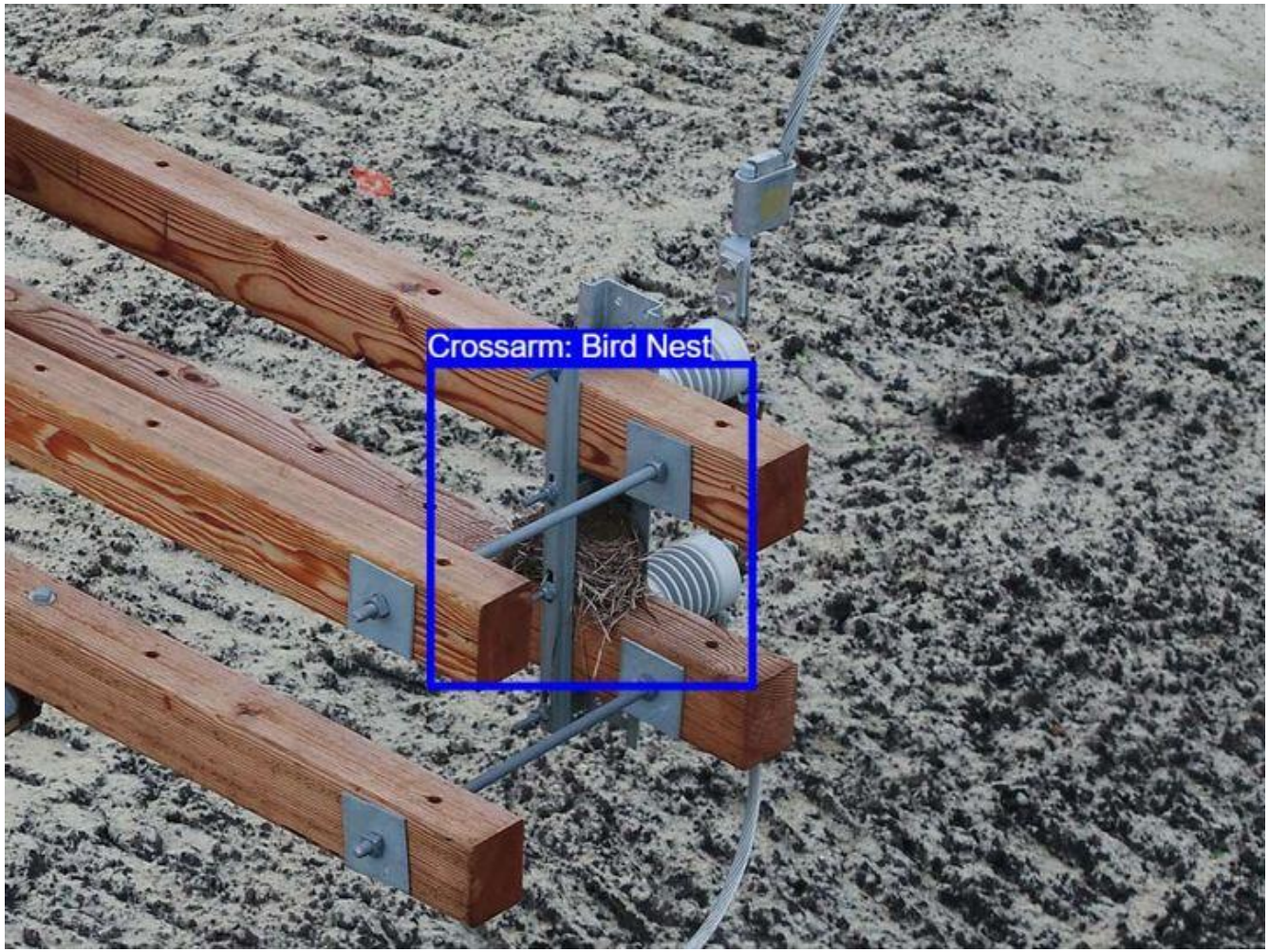

Inspection Results

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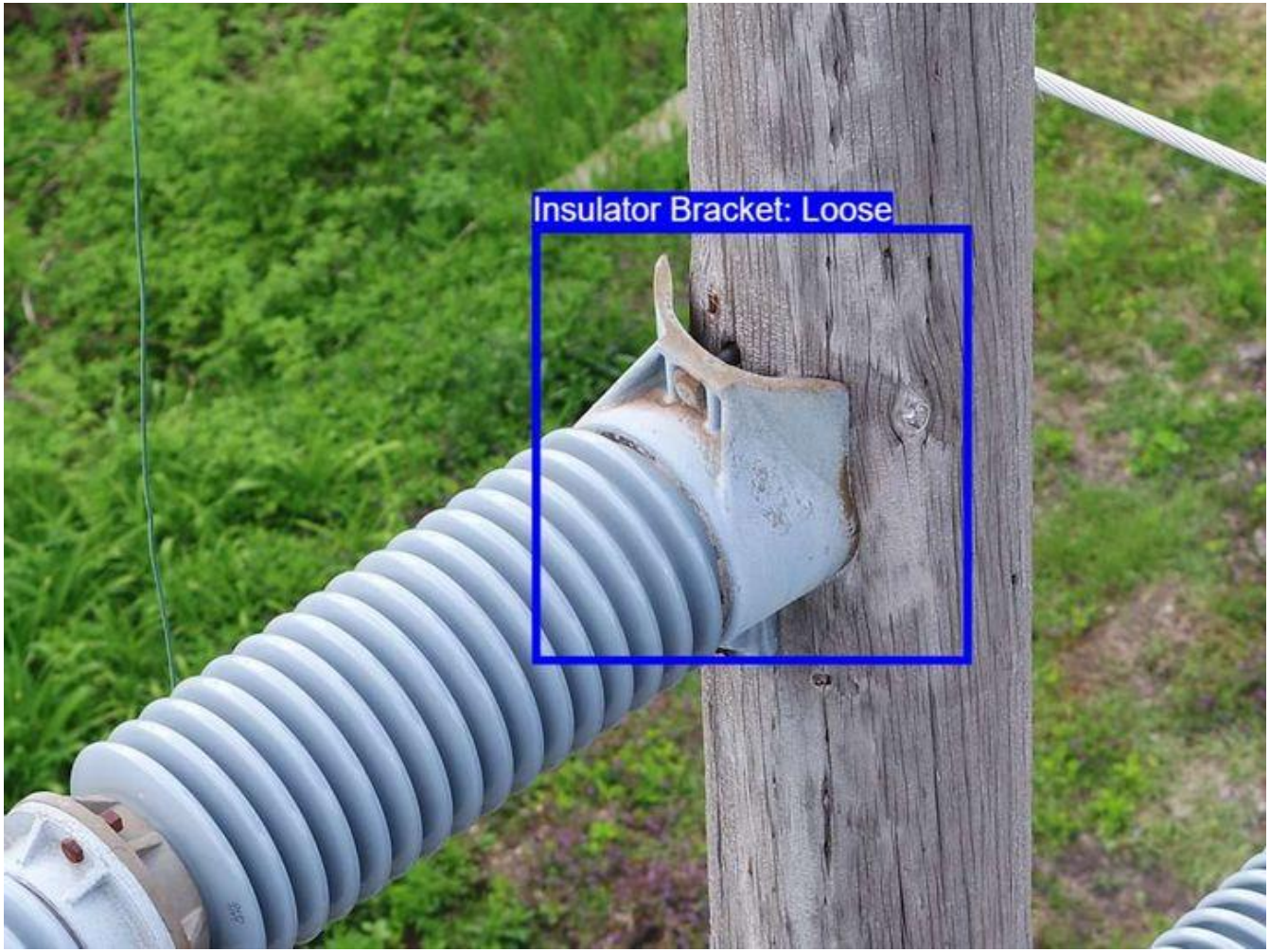

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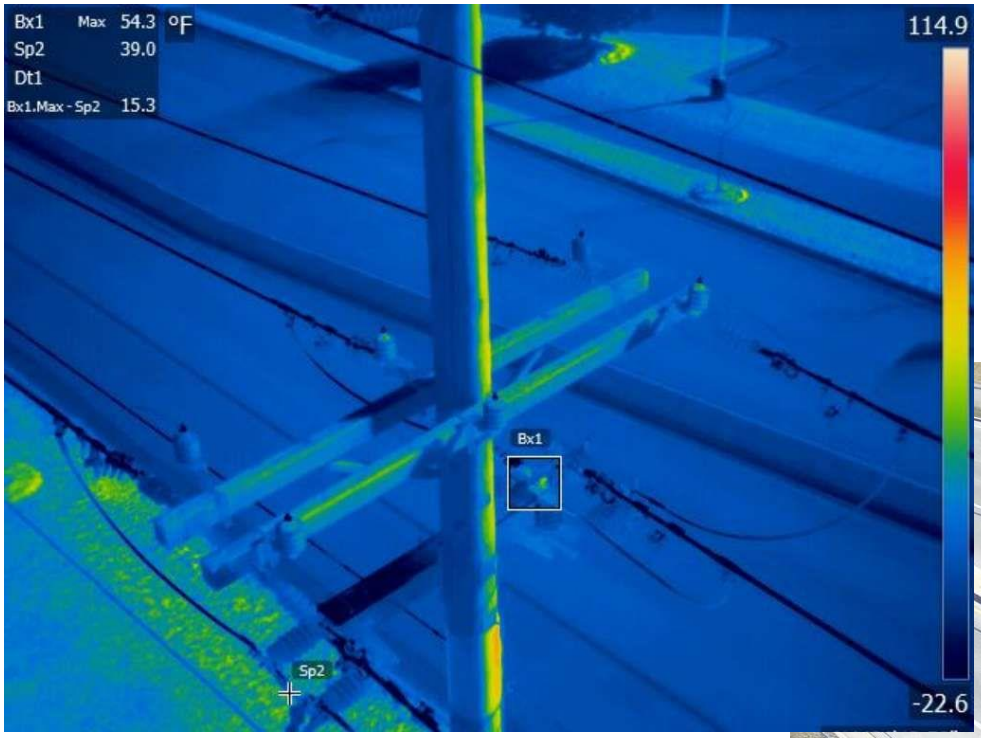

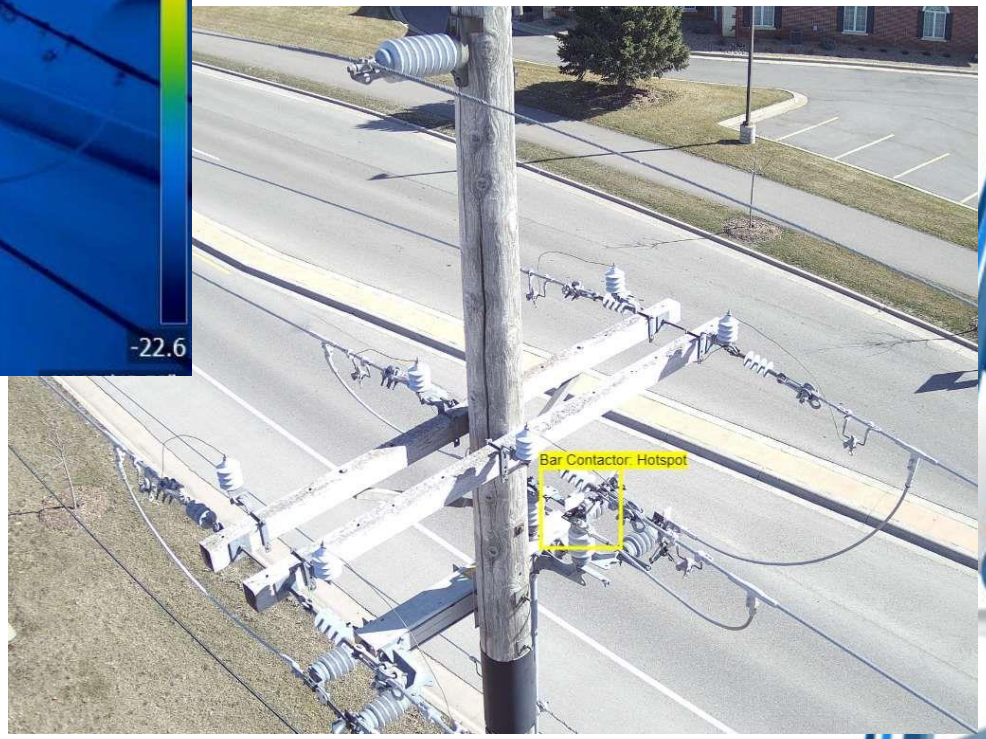

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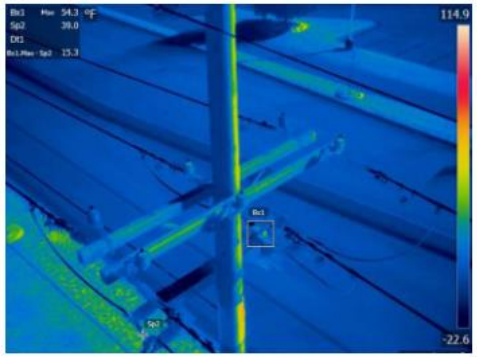
Inspection Results

CONDITION BASED MONITORING (CBM)

34.5kV Hydro Line

TOWER NAME	23554	TOWER TYPE	Wood
INSPECTION DATE	01/04/2021	COORDINATE	44.0787686388889,-92.4889218333333
TIME	11:11	AMBIENT TEMPERATURE	-1.00 °C
HUMIDITY	39%	WEATHER	Partially cloudy
THERMAL INSPECTION	Distribution		
	-		
BAR CONTACTOR		FORMULA	Δ = Max temp - Min temp

THERMAL IMAGE



MEASUREMENTS	
SPOT 1 / BX 1	12.39 °C
SPOT 2 / BX 2	3.9 °C
DELTA (Δ)	8.5 °C

SEVERITY	MONITOR	MINOR	CRITICAL
ΔT	7.2 - 14.4	14.5 - 27.0	> 27.0

THERMAL ANALYSIS

Abnormal Hotspot (ΔT: 15.3°C) detected at the unknown phase bar contactor connection area. (It might due to current leakage and aging e.g. wear and tear, e.g. poor connection, overtighten / loose contact issue).

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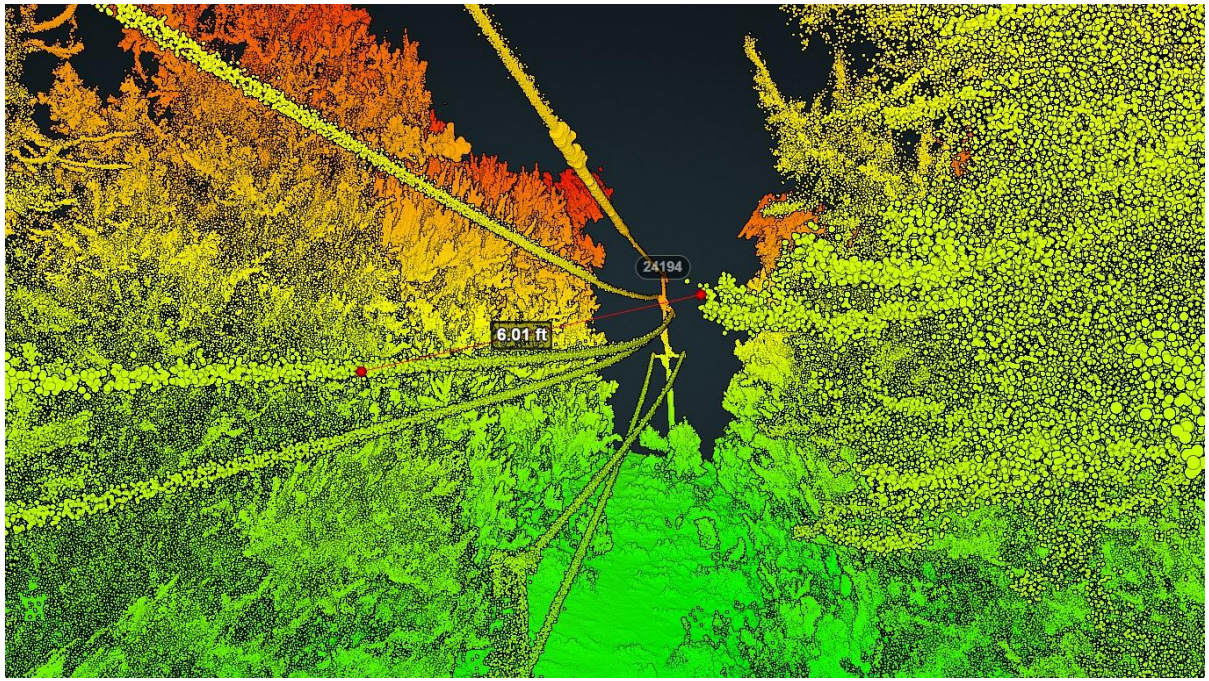
Inspection Results

- Later expanded inspections to include LiDAR surveys
  - Per span LAS files with cloud storage and web application
  - Per span vegetation encroachment reports
  - Used for vegetation monitoring and engineering solutions



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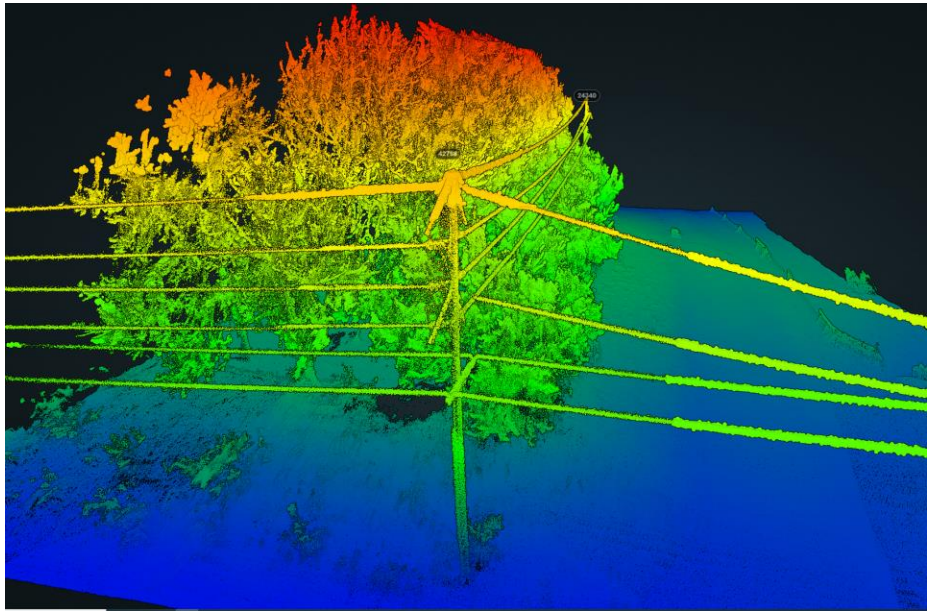

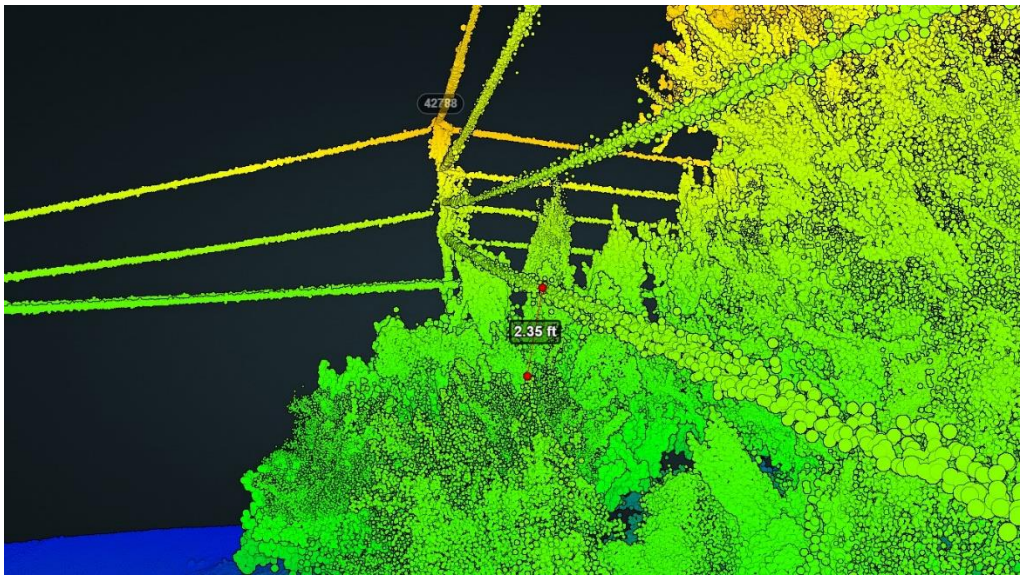

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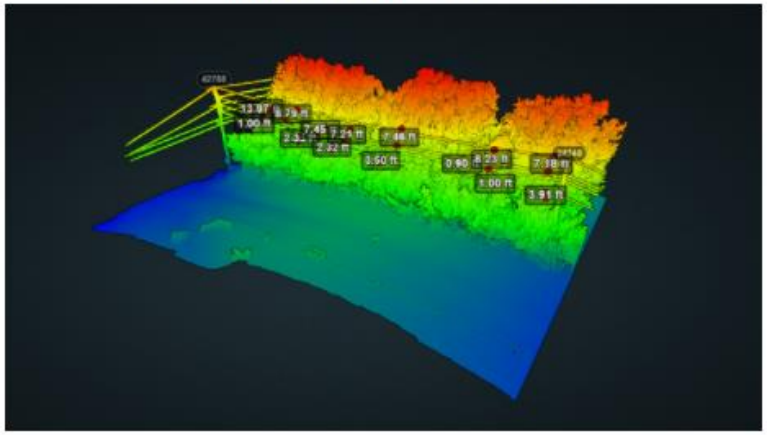
Inspection Results

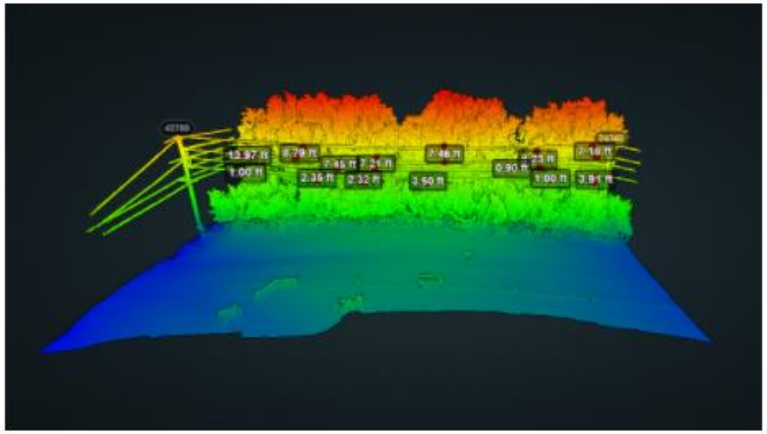
LiDAR INSPECTION

34.5kV Hydro Line

TOWER NAME	24340	FEEDER	34.5kV Hydro Line
COORDINATE	540817.438,4893201.06	INSPECTION DATE	01/04/2021
LIDAR SPAN	24340- 42788		
OVERALL SEVERITY	Critical	DISTANCE	0.90 feet

DATA CLASSIFICATION - OVERALL TREE CLEARANCE





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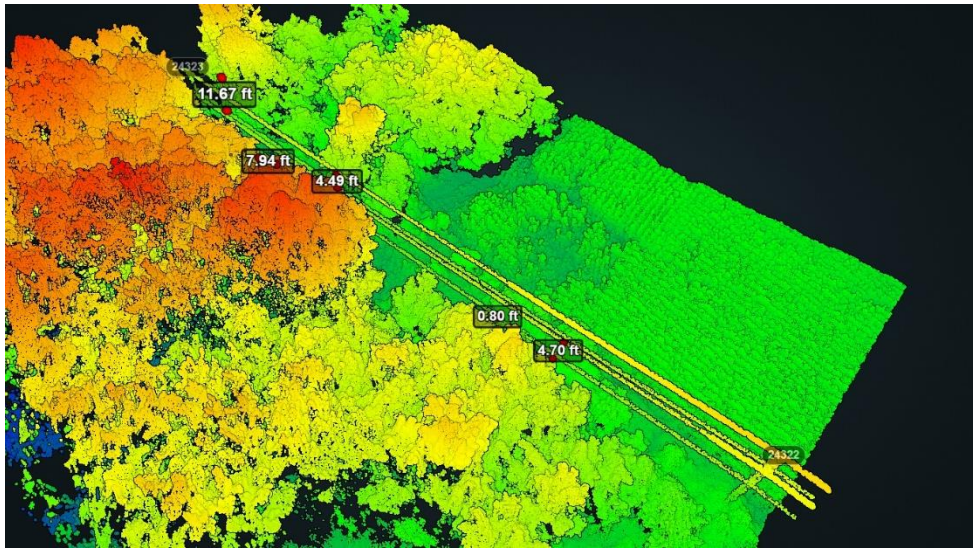

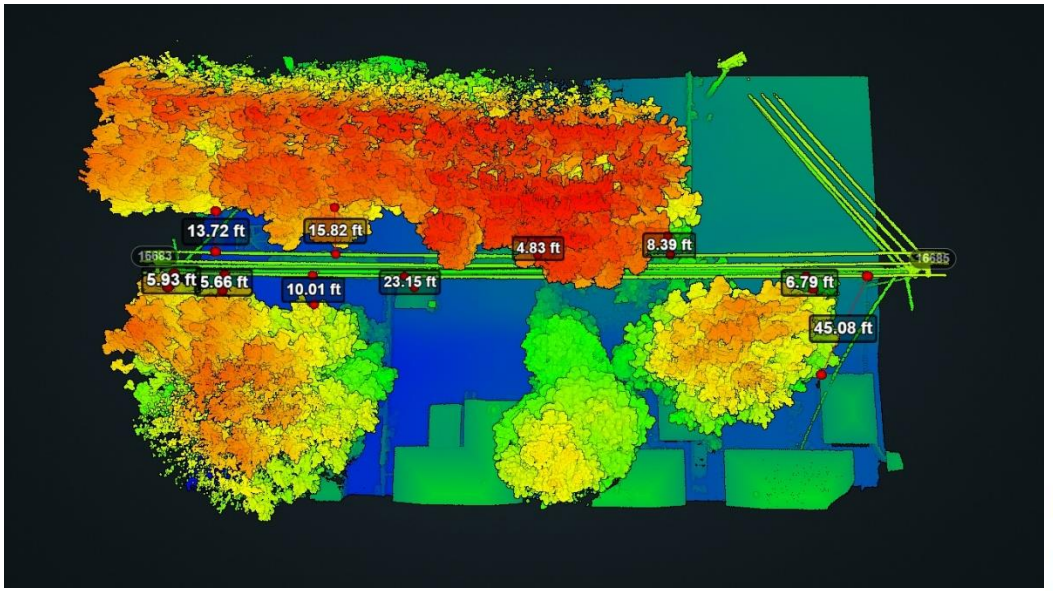

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Vision of Drone usage at RPU

- Hybrid drone inspection program
  - Large (geographically speaking) inspections will likely still leverage professional services
  - Small (geographically speaking) impromptu inspections will be done with internal staff and drone resources.
- Integration into other areas of the utility such as water tower inspections, building and other facility inspections.
- RPU pilots licensed for commercial use
- Data Management – Inspections will have a tie to GIS features to easily view search and view inspection photos.

Starting an internal program

- Identify hardware requirements
  - Two consumer-grade drones
  - RGB camera
  - Easy to learn, use, and deploy
- Narrowed down to 3 options
  - DJI Mavic 2 Pro
  - Skydio 2
  - Autel Robotics Evo II

DJI Mavic 2 Pro

Skydio 2

Autel Robotics Evo II

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Licensing & Training

- 4 staff members were part 107 certified
  - 10-15 hours of online training
  - Recurrent training required every 24 months
    - Replaced testing requirement in 2021
- On site flight instruction
  - FAA rules and regulations, weather, and safety
  - Basics of flight
  - Practical training & training and live structures
    - Confidence in the equipment and sensors

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Standard Operating Procedures & Safety

- Developed safety focused SOPs that exceed FAA regulations
- Created a number of checklists to ensure uniform operations
  - Cover everything from pre-flight, typical take off and landing, to accident reporting and lost aircraft
- All flights are communicated to System Operations and logged via ArcGIS Online

IN-FLIGHT EMERGENCY CHECKLIST
BIRD OR FIXED OBJECT STRIKE
REMAIN CALM AND ANNOUNCE THE EMERGENCY TO THE FLIGHT CREW **– IF THE AIRCRAFT CAN BE CONTROLLED –** ☐ Send the aircraft the "Return to Home" command or land as quickly as possible ☐ Notify the UAS Coordinator **– IF THE AIRCRAFT CAN BE PARTIALLY CONTROLLED –** ☐ Follow the procedures for **Partial Loss of Power** Emergency **– IF THE AIRCRAFT CANNOT BE CONTROLLED –** ☐ Follow the procedures for **Total Loss of Power** Emergency

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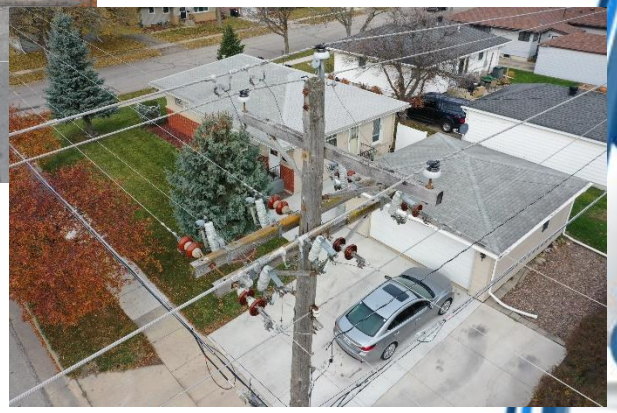
Pole Inspection



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Lessons Learned

- Identified a season based on weather and temperatures
  - Cold weather greatly reduces battery life and increases inspection times
- Data overload
  - Collect data faster than we can process it
- Internal drones for small inspections and professional services for larger inspections

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Moving Forward

- Expand our inspection capabilities
  - Hydroelectric dam, water towers, facilities inspections
- Automate/expedite data processing and fleet management
  - Software and algorithms to process data and create actionable reports
- Expand our pilot group
  - Train and licence field staff
  - Push hardware out to where it can be immediately deployed

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Questions?

Thank You!

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